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SILVICULTURE OF PONDEROSA PINE

IN THE CENTRAL AND SOUTHERN ROCKY MOUNTAINS

by Wayne D. Shepperd, Robert R. Alexander, and Frank Ronco, Jr.

USDA Forest Service
Rocky Mountain Forest and Range Experiment Station
FORT COLLINS, COLORADO

RM-TT-4

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PREFACE

Rocky Mountain ponderosa pine (*Pinus ponderosa* var. *scopulorum* Engelm.) is a species of major importance in the Rocky Mountain and southwestern regions. It occupies over 11 million acres in the Southwest and montane zone of the Central Rockies, and over a million acres in the Black Hills of Wyoming and South Dakota. Intermediate in tolerance, ponderosa pine is adaptable to both even- and uneven-aged management.

Because of climatic differences between the Black Hills and the Southwest, and differences in susceptibility to dwarf mistletoe and insect attack, a variety of silvicultural techniques are needed for successful management of ponderosa pine. It is important, therefore, that silviculturists and forest managers understand the interrelationship of these factors in order to choose the proper silvicultural treatment for a stand.

This booklet and the accompanying slide-tape presentation are designed to provide a concise summary of the ecology and silvicultural practices available for use in ponderosa pine forests in the central and southern Rockies. Please keep this booklet as a handy reference to help you recall the subjects presented in the talks, and also locate additional literature where you can find the original research covering the topics. You can obtain copies of most of the references cited by contacting Publications Distribution, Rocky Mountain Forest and Range Experiment Station, 240 West Prospect, Fort Collins, CO 80526.

This slide-tape presentation has been distributed to all National Forests in the central and southern Rocky Mountain area that manage the ponderosa pine type. Information concerning the purchase of additional copies of this or other slide-tape and booklet sets in this series can be obtained from the USDA Forest Service Rocky Mountain and Southwestern Regional Offices, or by writing:

Public Affairs Officer
USDA Forest Service
Rocky Mountain Forest and Range Experiment Station
240 West Prospect
Fort Collins, CO 80526

Other titles in this series include the following:

Overview to Silvicultural Systems in the Central Rocky Mountains (RM-TT-1)

Silviculture of Spruce-Fir Forests in the Central Rocky Mountains (RM-TT-2)

Silviculture of Lodgepole Pine in the Central Rocky Mountains (RM-TT-3)

August 1983

Silviculture of Ponderosa Pine in the Central and Southern Rocky Mountains

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[1]Headquarters is in Fort Collins, in cooperation with Colorado State University.

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1

1. . . . 2. . . . 3. . . . (musical interlude)

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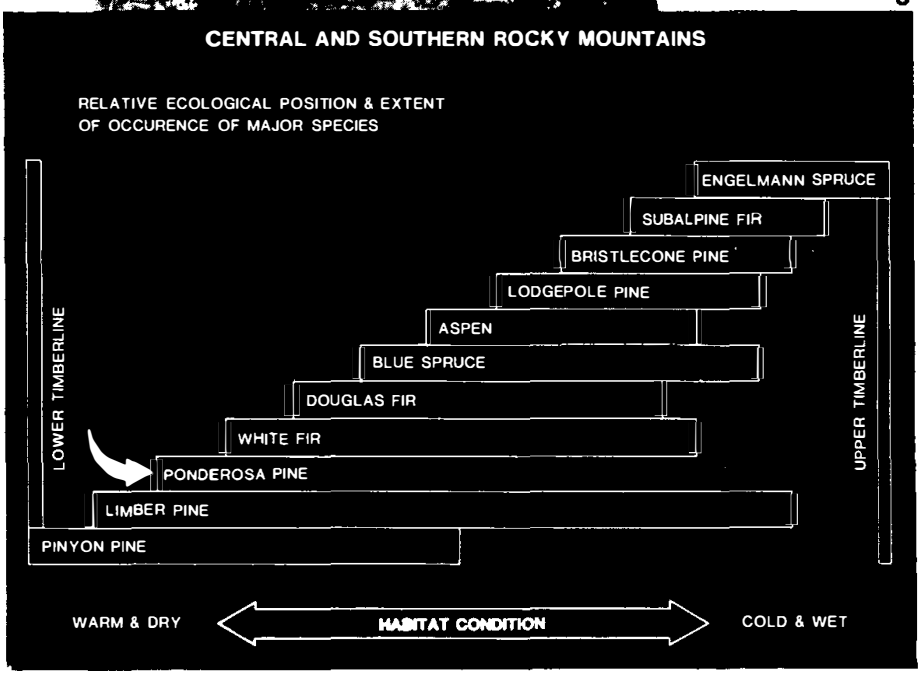
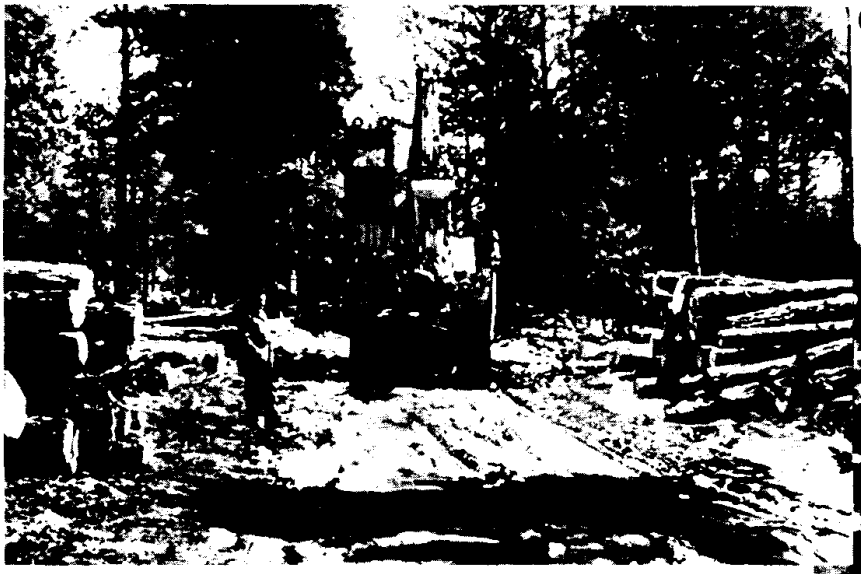
4. Throughout the mountains of the Southwest, the Front Range of the Rocky Mountains, and the Black Hills of South Dakota and Wyoming, stands of the long-needled, stocky ponderosa pine are familiar sights.

5



5. This Rocky Mountain variety of the ponderosa, *Pinus ponderosa* variety *scopulorum,* occurs at lower elevations than most other conifers in the Rockies, and it's adapted to the warm dry sites found within its ecologic range.



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7

8

6. These ponderosa forests are a valuable source of timber and other forest products . . .

7. . . . provide habitat for many wildlife species . . .

8. . . . and abundant forage for elk, deer, and livestock alike.

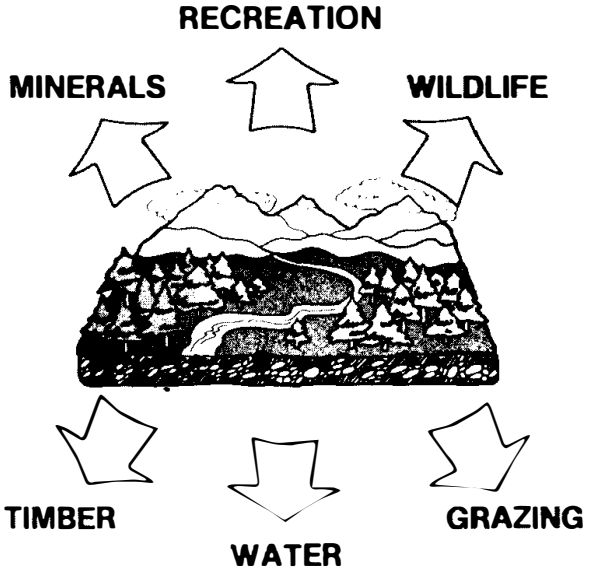
9. They are also a place to get away from the hustle of city life . . .

10. . . . and they provide water for domestic, commercial, and agricultural needs.

9

10

11. Today, forest managers must meet increased demands for limited forest resources without serious damage to the environment.



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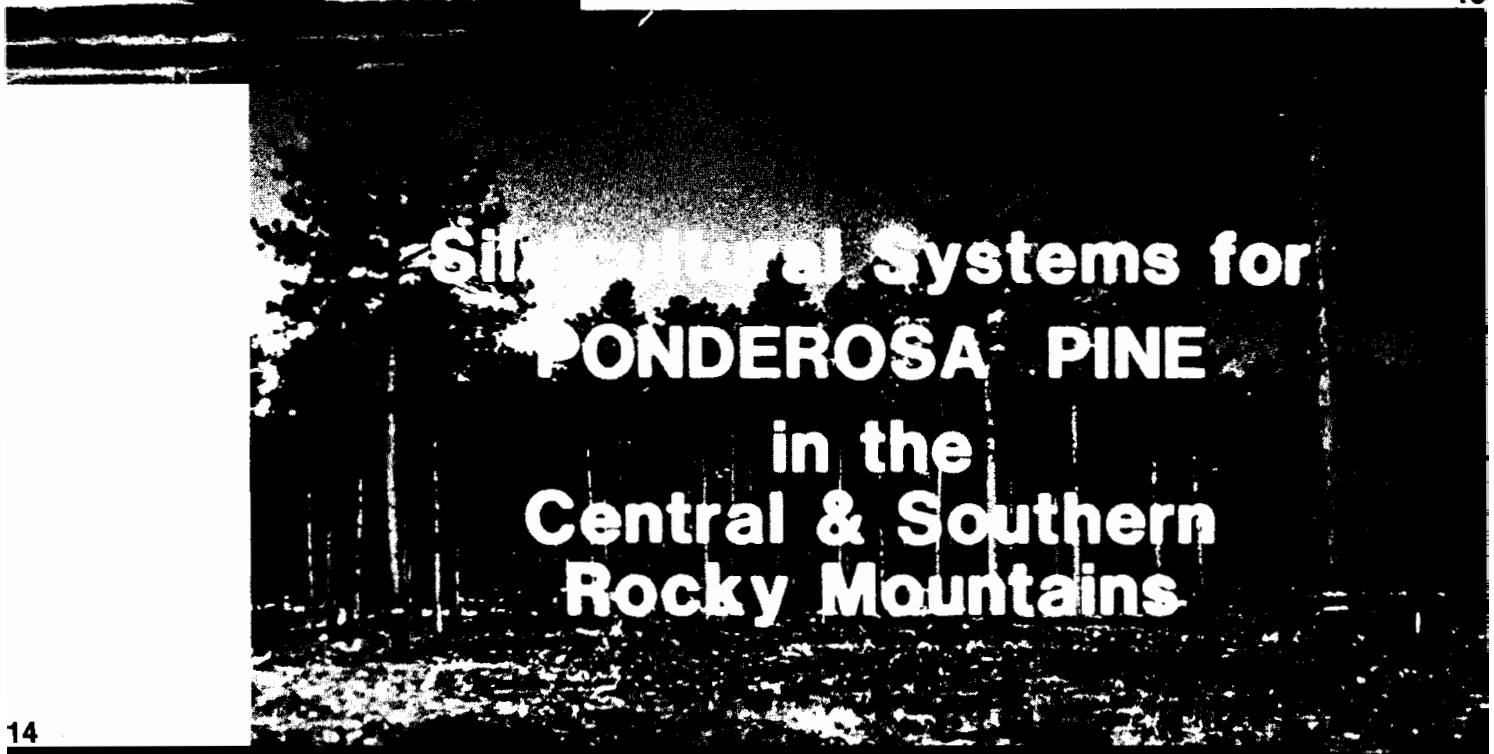
12. This program plus the introductory "Overview" and companion slide tapes are designed to help you make better decisions for more productive forests.

13



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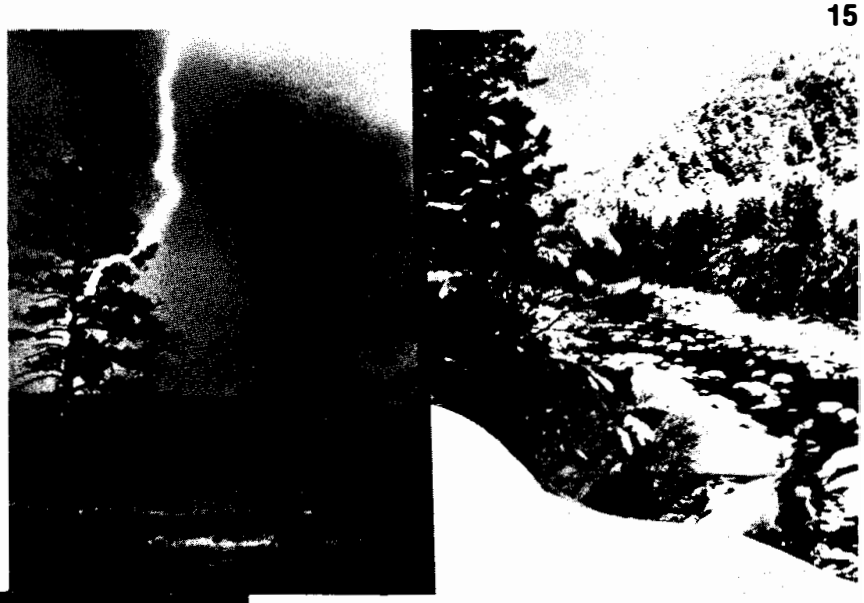
SILVICS OF PONDEROSA PINE

15. The silvicultural practices used with Rocky Mountain ponderosa pine vary because of the distinct climatic differences within its range. For instance, in the Black Hills, most of the precipitation comes in the summer, just when it's needed the most for regeneration. But in the Southwest and the Front Range of the Rockies, much of the precipitation comes in winter snow storms, which are usually followed by a dry spell in June and July. This pattern makes regeneration unreliable.

15



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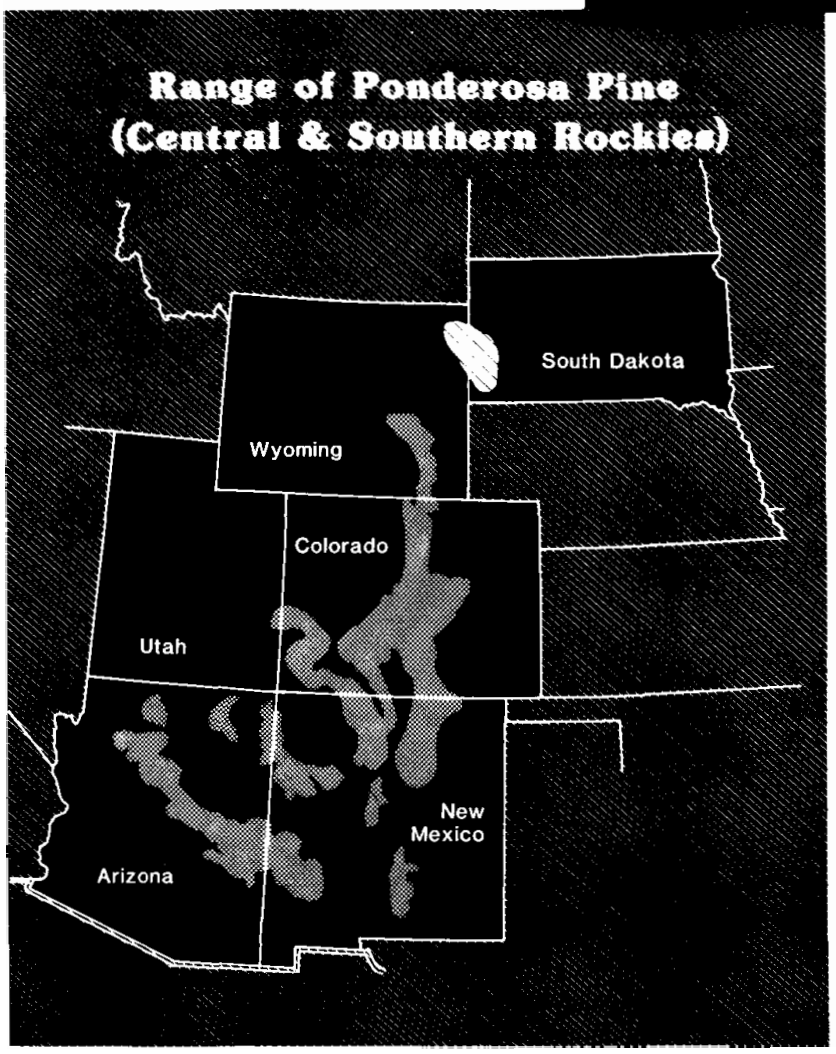

16. We will, therefore, discuss the silvicultural practices applicable to Black Hills ponderosa pine, shown here in green, separately from those which apply to ponderosa pine in the Front Range of the Rockies and the Southwest, shown in red on the map.

BLACK HILLS PONDEROSA PINE

17. Ponderosa pine is the main cover type on approximately one million acres of the Black Hills and Bear Lodge Mountains of South Dakota and eastern Wyoming at elevations of between 4,300 and 6,000 feet. It occurs in several different plant associations (Larson, 1980).

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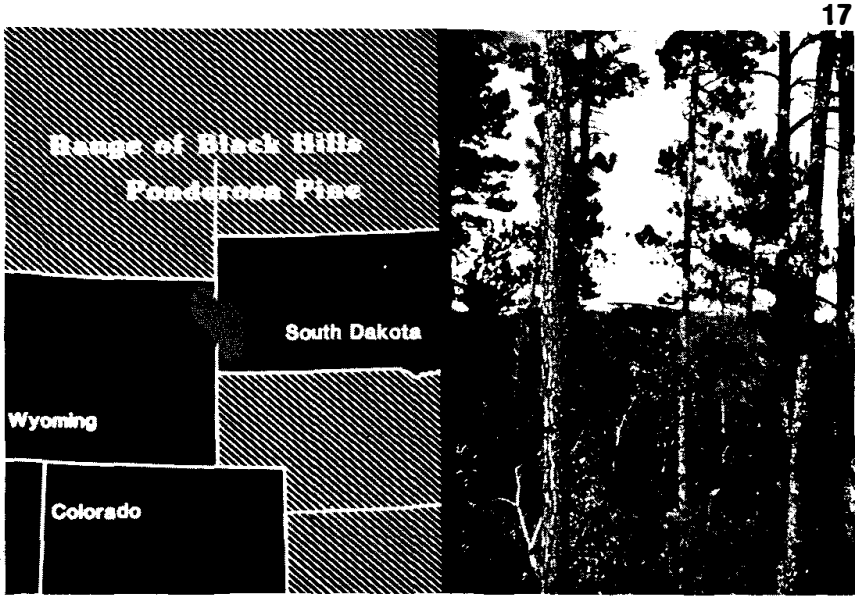

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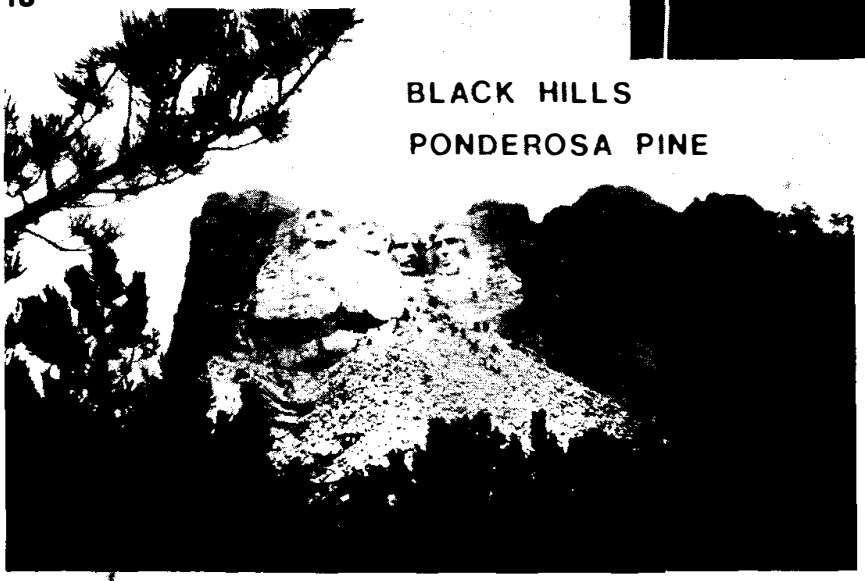


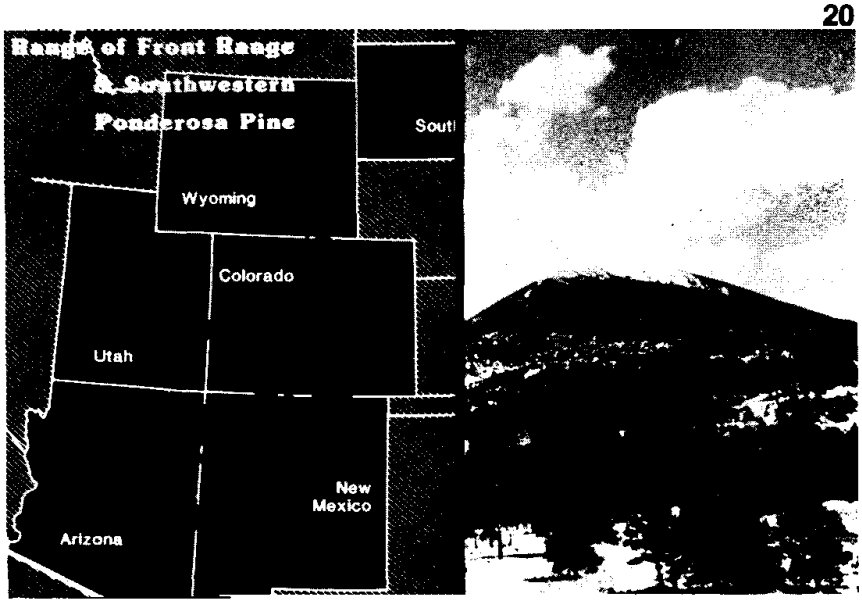
18. Black Hills ponderosa pine forests form a unique, isolated segment of the ponderosa pine type. However, management is simplified in these forests because they reproduce easily and are free of dwarf mistletoe.

19. Black Hills ponderosa pine occurs mainly as a climax species and, for the most part, is found in pure stands. After fire or other disturbances, these stands are temporarily replaced by other plant communities but soon return to ponderosa pine.

19

FRONT RANGE AND SOUTHWESTERN PONDEROSA PINE

20. Southwest of the Black Hills, ponderosa pine covers extensive areas along the Front Range of the Rocky Mountains, and in southern Colorado. On the Colorado Plateau in Arizona and New Mexico, it forms the largest contiguous stand of ponderosa in the United States. These forests are found primarily between 6,000 and 8,500 feet in elevation. At lower elevations . . .



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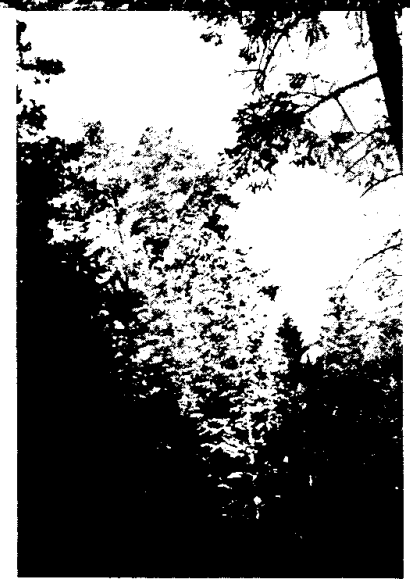
21. . . . ponderosa pine intergrades with pinyon-juniper. This dry, marginal zone, referred to as the "fringe pine" zone, encompasses several hundred thousand acres in the Southwest. But since we are only concerned here with commercial stands, we will not be discussing the special management considerations needed in these stands of fringe pines.



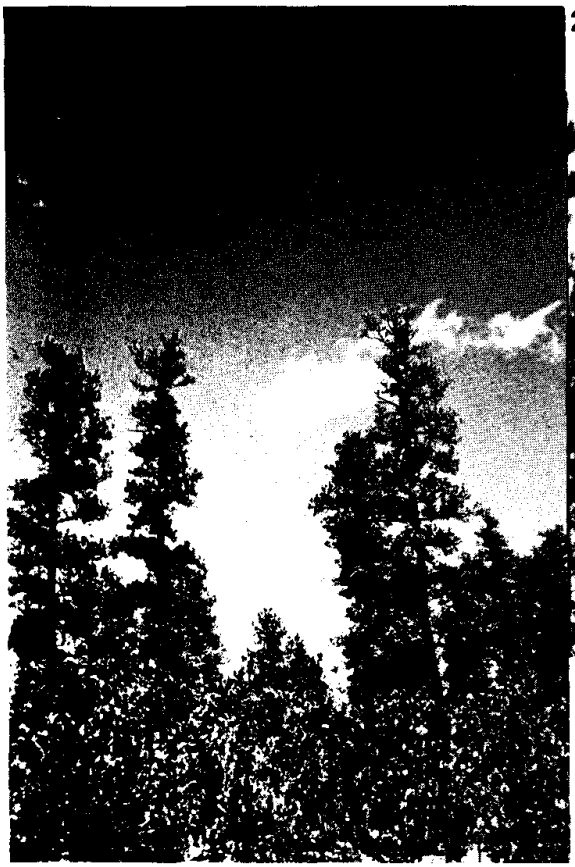
22

22. On the other hand, at higher elevations, ponderosa is gradually replaced by other conifers such as Douglas-fir, lodgepole pine, white fir, Engelmann spruce, and subalpine fir. Several habitat and community types have been recognized; however, vegetation classification of Front Range and southwestern ponderosa pine forests is not yet completed (Hanks et al 1983), Hess 1981, Hess and Wasser 1982).

STAND CONDITIONS

23. Throughout the Rocky Mountains, Black Hills and Bear Lodge Mountains, ponderosa pine exhibits several distinctive stand conditions.

BLACK HILLS PONDEROSA PINE



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26

24. In the Black Hills, the most common situation is the transitional, two-aged stand, composed of a light overstory of old-growth trees above dense second growth (Boldt and VanDusen 1974).

25. Most of the remaining forest is made up of dense, uniformly spaced trees. These stands are mostly immature, even-aged stands, free of overstory.

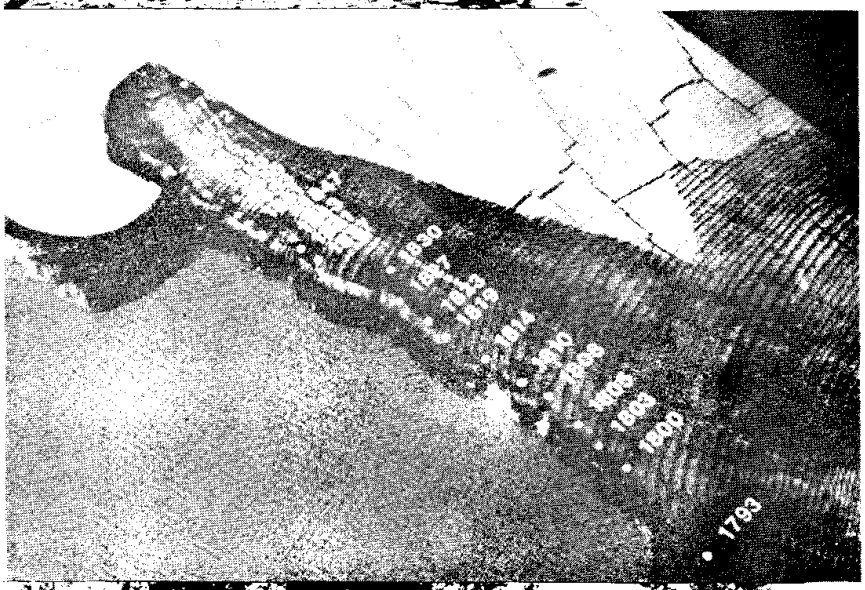
26. Occasionally, uneven-aged stands are found in the Black Hills. These usually occur where ponderosa pine invades grassy park-like areas, or in old burns, where there has been prolonged protection from wildfires.

FRONT RANGE & SOUTHWESTERN PONDEROSA PINE

27

27. Compared to stands in the Black Hills, ponderosa pine stands in the Front Range and Southwest are usually more open-grown, often poorly stocked, and interspersed with meadows and parks (Schubert 1974).

28



28. Over the years, fire has played a prominent role in the development of southwestern ponderosa pine stands. Through the dating of fire scars in Arizona, scientists have observed a history of frequent fires prior to this century.

29

29. Such stands are usually irregular and uneven-aged groups that vary in size from a few trees to several acres. Past cutting, involving a variety of partial cutting practices, has preserved the uneven-aged structure of these stands (Schubert 1974).

30. However, occasional even-aged stands grow where fires created open areas, and where regeneration is the result of clearcutting.

30

REGENERATION

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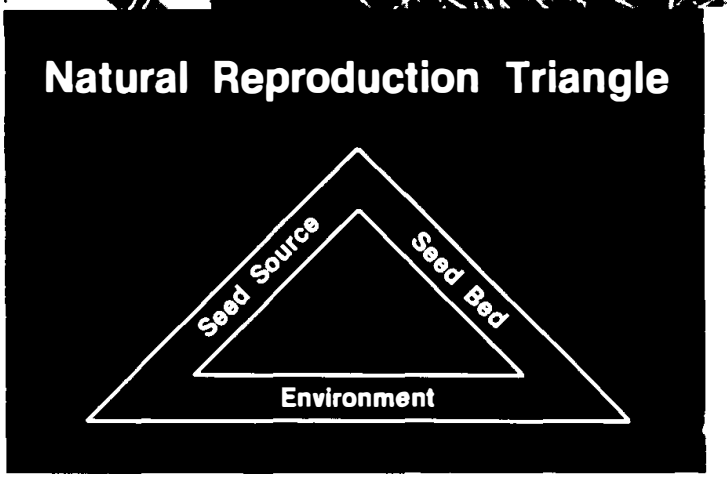
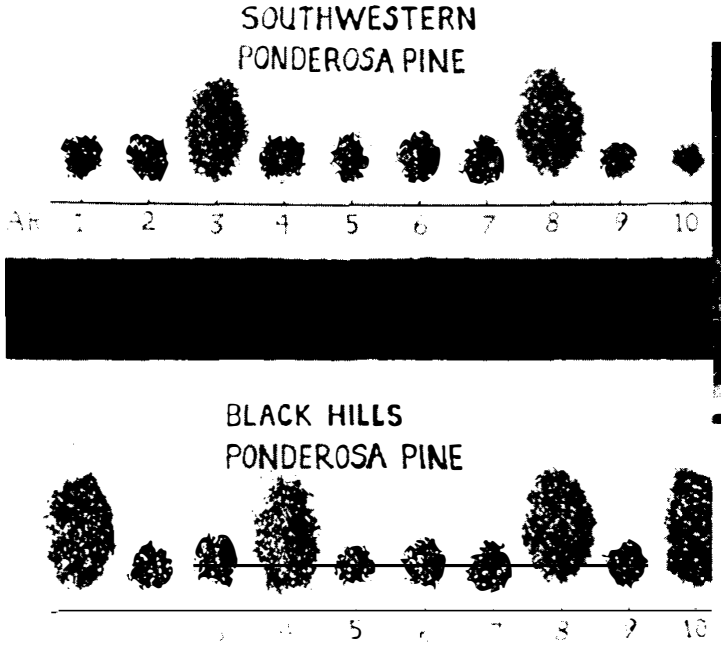


31. Regeneration of harvested areas (Ronco 1979a) is an important consideration of any management plan. Natural reproduction of both Black Hills ponderosa pine and southwestern ponderosa pine depends upon...

32. . . . a suitable **seedbed,** ample **seed supply,** and an **environment** compatible with germination and establishment. These conditions seldom coincide in the dry Southwest. Of these three factors, the first (seedbed preparation) is discussed in more detail in the accompanying "Overview" and other slide-tapes (Ronco 1979b), so we won't deal with it further here.

SEED SOURCE

33-34



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36

33. However, the second factor, seed supply, warrants some discussion. As you can see here, southwestern Ponderosa pine usually produces light seed crops; good seed crops are only produced every 4 or 5 years. However, remember that good seed crops alone are not enough — they must coincide with adequate site preparation and sufficient rainfall to regenerate stands (Schubert 1974).

34. On the other hand, as you can see in the lower frame, Black Hills ponderosa is a dependable seed producer. Good to excellent crops are produced at intervals of two to five years, with lighter crops in intervening years (Boldt and VanDusen 1974).

35. The large, heavy seeds produced by ponderosa pine . . . .

36. . . . limit the area that can be naturally seeded to three to four times the crown radius.

ENVIRONMENT

37

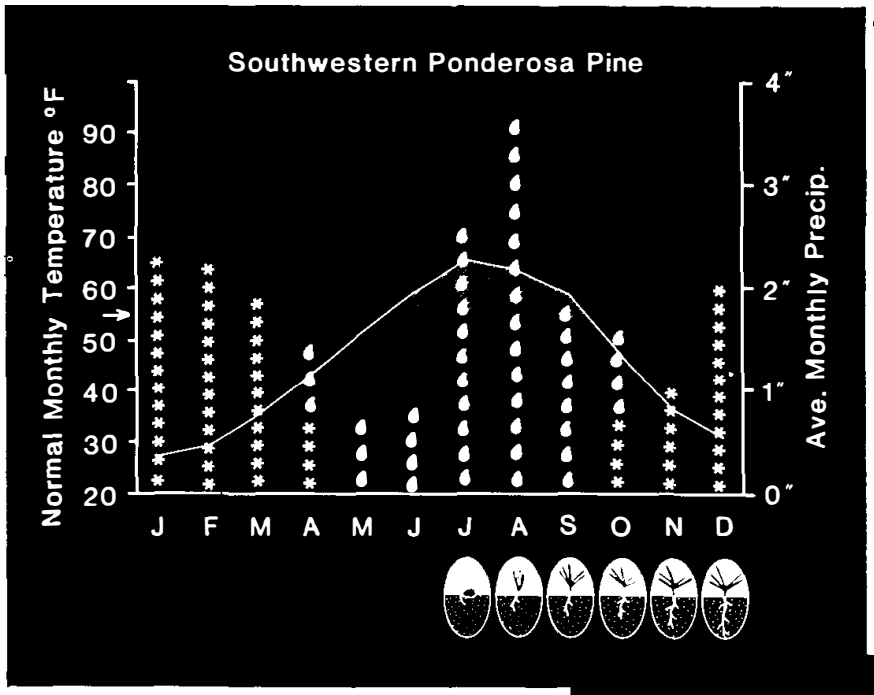
38

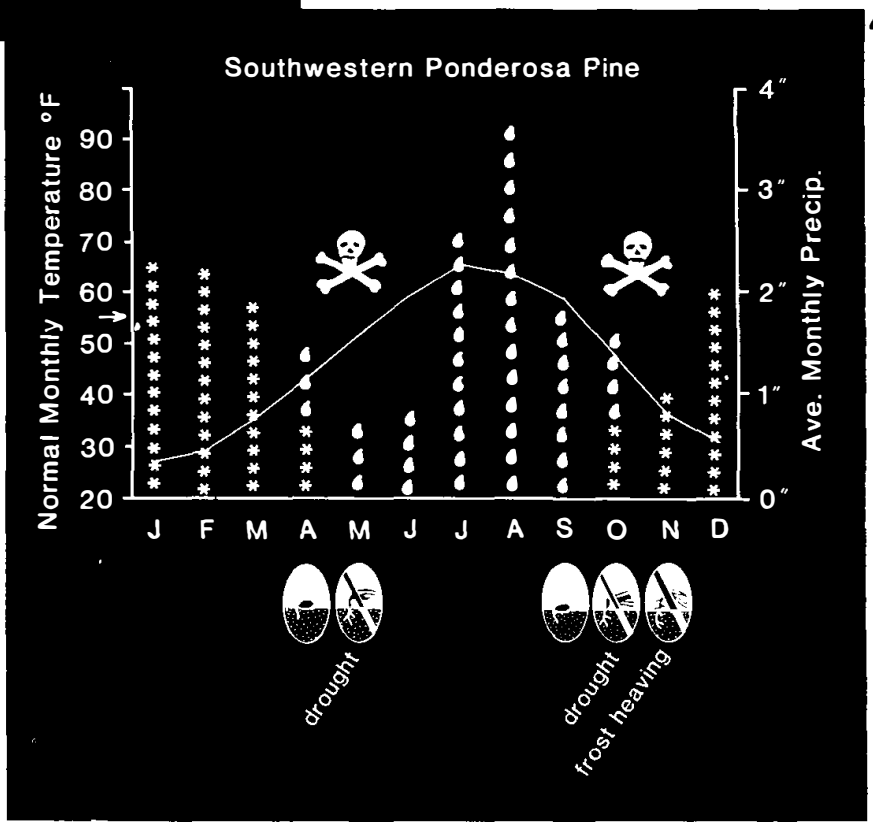
39

37. The best trees to retain for seed production are 24 to 28 inches in diameter, dominant, disease free, and show evidence of having produced good cone crops. Leave these trees around the edges of cleared areas or scattered in cut areas.

38. Another important seed source is cones scattered on the ground during cutting, if cutting is timed to coincide with cone maturity.

39. As we mentioned earlier, conditions for germination vary considerably between the Rocky Mountains and Southwest and the Black Hills.

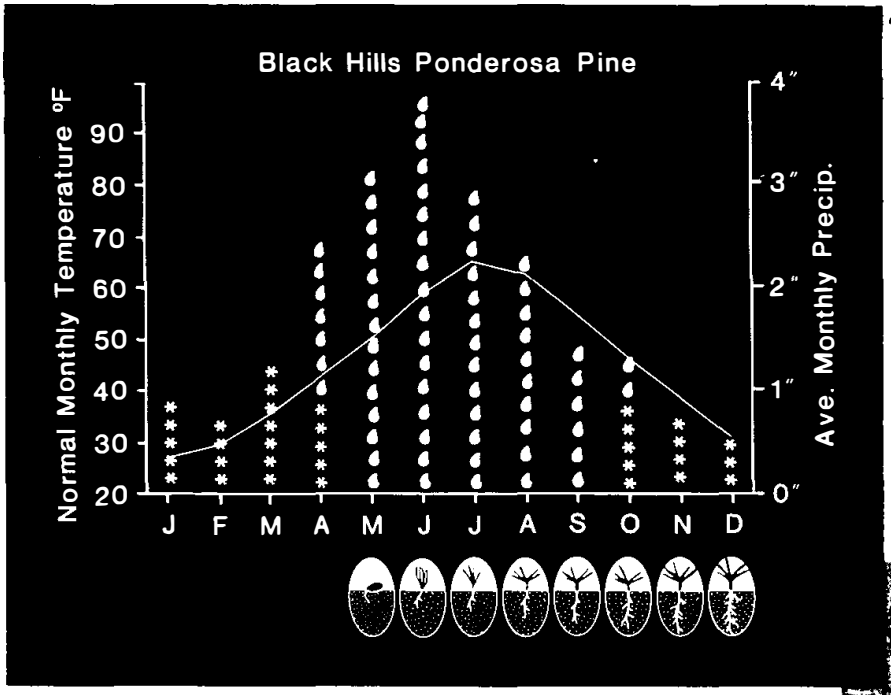




40. In the Southwest, for instance, the climate in the pine zone is warm and relatively dry. Germination can occur as soon as the average temperature exceeds 55 °F, as shown by the pink zone on the white temperature curve, but there normally isn't sufficient moisture until many weeks later, as shown by the blue symbols.

41. So germination in the Southwest usually is delayed until July, when the summer rains start.

42. If the rains start either too early or too late, seeds will still germinate; but the undeveloped seedlings may be headed for disaster and may either be killed by subsequent drought or by winter frost-heaving.



43

43. On the other hand, rainfall in the Black Hills is more reliable and abundant, so viable seeds normally germinate in early summer, when seedbeds are moist and warm. This unique combination of ample seed and abundant spring and summer rainfall in the Black Hills greatly simplifies management for regeneration.

44

44. Ponderosa pine is well adapted to establishment in open areas. However, because moisture is the most limiting factor in germination, a light overstory shade will increase both survival and early growth of seedlings. This is because the lowered air temperature in shaded areas reduces moisture loss from both seedlings and soil.

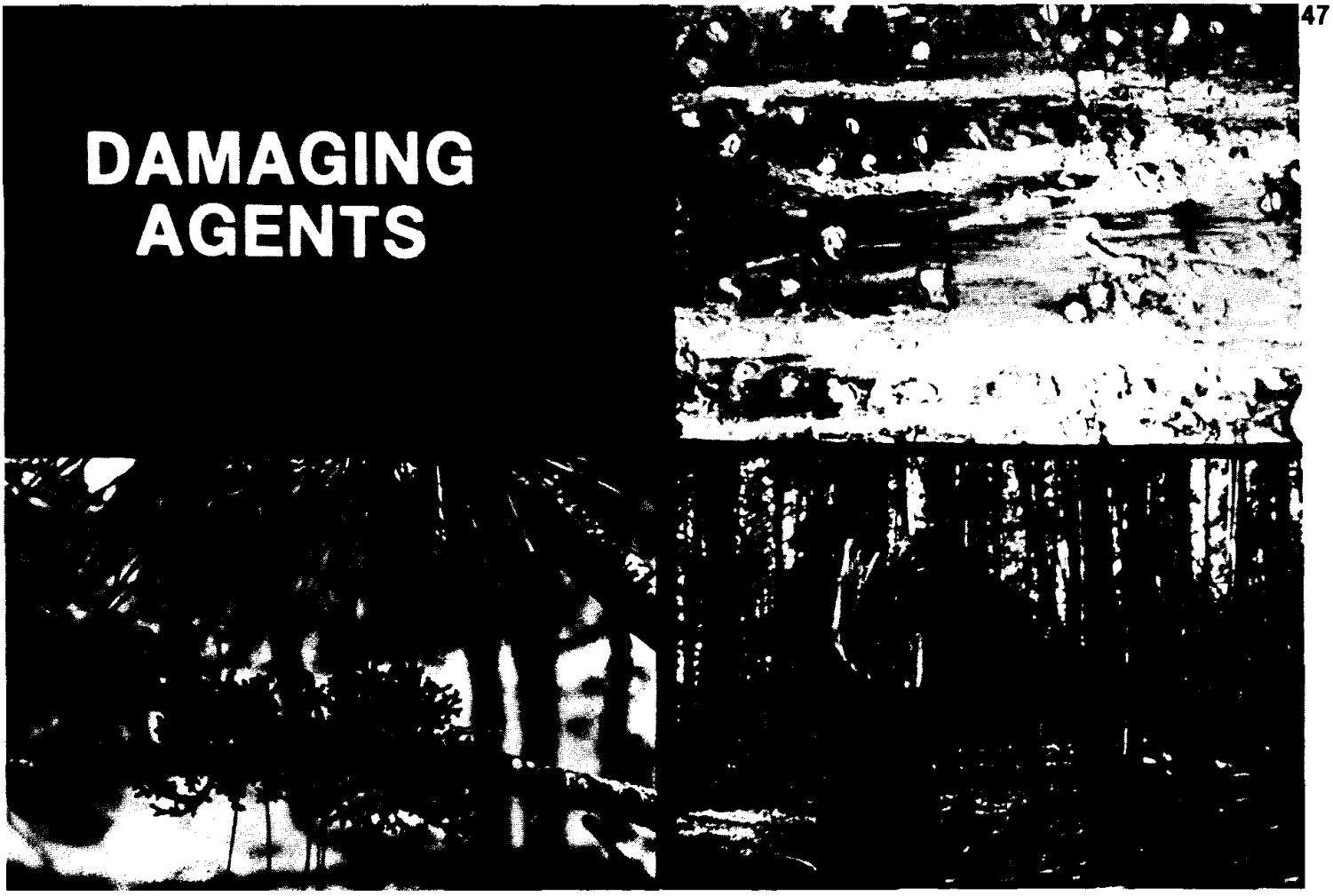
45

45. Shade also prolongs the snow cover, which reduces the daily thawing of bare ground and the danger of frost heaving. Frost heaving occurs . . .

46. . . . when ice lenses lift the surface of the soil, which is frozen tightly to the stem of the seedling. This action forces the seedling up out of the soil. Frost heaving is more of a problem in volcanic soils than in sedimentary soils because of the high silt content (Heidmann and Thorud 1976).

46

DAMAGING AGENTS



47. There are several damaging agents that limit the growth and survival of seedlings and mature trees alike. For example, . . .

BIRDS AND MAMMALS

48. . . . squirrels and other small mammals eat significant amounts of seed (Schopmeyer 1974).

49. Voles and pocket gophers damage stems and root systems (Crouch 1983) . . .

50. . . . and small birds, such as juncos, clip off new growth.

51. Livestock and big game browse and trample young seedlings (Currie, et al 1978).

GRASS

52

52. And even dense grass and other vegetation can inhibit the growth of young seedlings. If it's **thick** enough, grass can smother seedlings and rob them of soil moisture (Larson and Schubert 1969).

FIRE

53

54

55

53. Older trees are also vulnerable to damage. Because of the relatively dry habitat, fire is a conspicuous damaging agent. Fire damage occurs mainly in poles, saplings and seedlings. Crown fires are less likely to occur in widely spaced stands. Because of their thick bark, older trees are quite resistant to ground fires; but hot fires will destroy all trees.

54. Firescarred trees have a lower market value and their trunks are more susceptible to decay.

55. However, fire can also be a useful tool in the management of ponderosa pine. Prescribed burning is currently being used to provide improved seedbeds for natural regeneration, to lower the amount of fuel load, . . .

56. . . . to reduce understory shrub competition, . . .

57. . . . to improve both the quantity and quality of understory vegetation, and control the invasion of meadows by young ponderosa pine.

56

57

INSECTS

58. Insects and diseases also take their toll on ponderosa pine forests. Mountain pine beetle is the most aggressive insect pest in Rocky Mountain ponderosa pine (McCambridge, et al 1979; Parker and Stevens 1979). Outbreaks are usually devastating in dense, second-growth stands.

59. However open-grown trees are also at risk under outbreak conditions.

60. Trees damaged in forest fires, road building, and logging are more susceptible than healthy trees.

61. And in dense stands, trees greater than 6 inches DBH, such as these, are particularly susceptible.

62. The **best practice** is to **prevent** beetle outbreaks by using proper silvicultural practices to maintain stand vigor (McCambridge, et al 1982, McCambridge and Stevens 1982). Direct control (that is, killing beetles in infested trees), is a last-resort by which you can sometimes minimize your losses (Stevens, et al 1975).

DISEASES

63

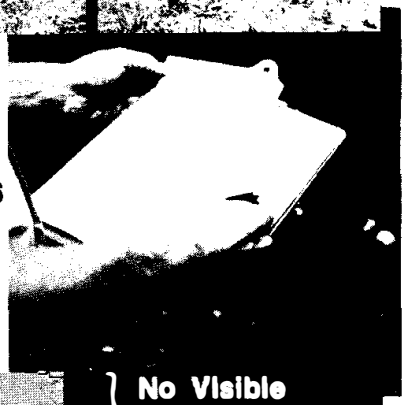
64

63. Dwarf mistletoe is another damaging agent, except in the Black Hills. A major disease affecting ponderosa, mistletoe infects trees of all ages and may kill small trees in a short time.

64. Older, larger trees die more slowly, but their growth is reduced drastically. Dwarf mistletoe is most damaging in stands partially opened by cutting, mountain pine beetles, or in windfall areas. Regenerated burns seem to be least affected.

65

65. Two methods you should consider to control dwarf mistletoe in the Southwest are first, the removal of infected overstory trees after regeneration, with thinning in the understory to maximize growth of individual trees; or second, stand eradication by clearcutting in severely infected stands. You'll find that simulated yield models are excellent tools for determining your alternatives.

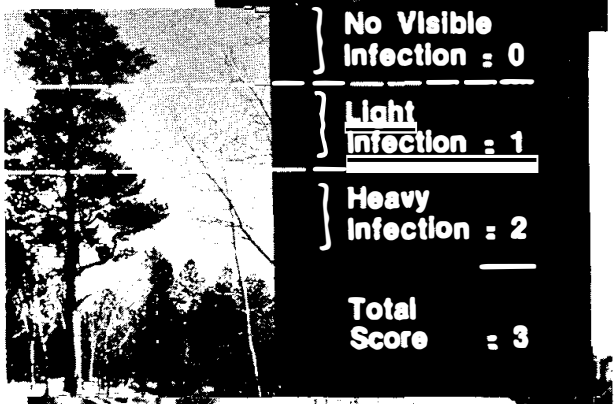


66

66. Inspect each stand carefully, and use the **six-class rating system** (Hawksworth 1977) to determine the severity of the infection. Under this system, individual trees are treated differently.

67. First, divide the crown into thirds and rate each third separately. For example, if the upper third has no visible infection, its rating is zero.

67-70



68. If the middle third is lightly infected, then the rating is "one."

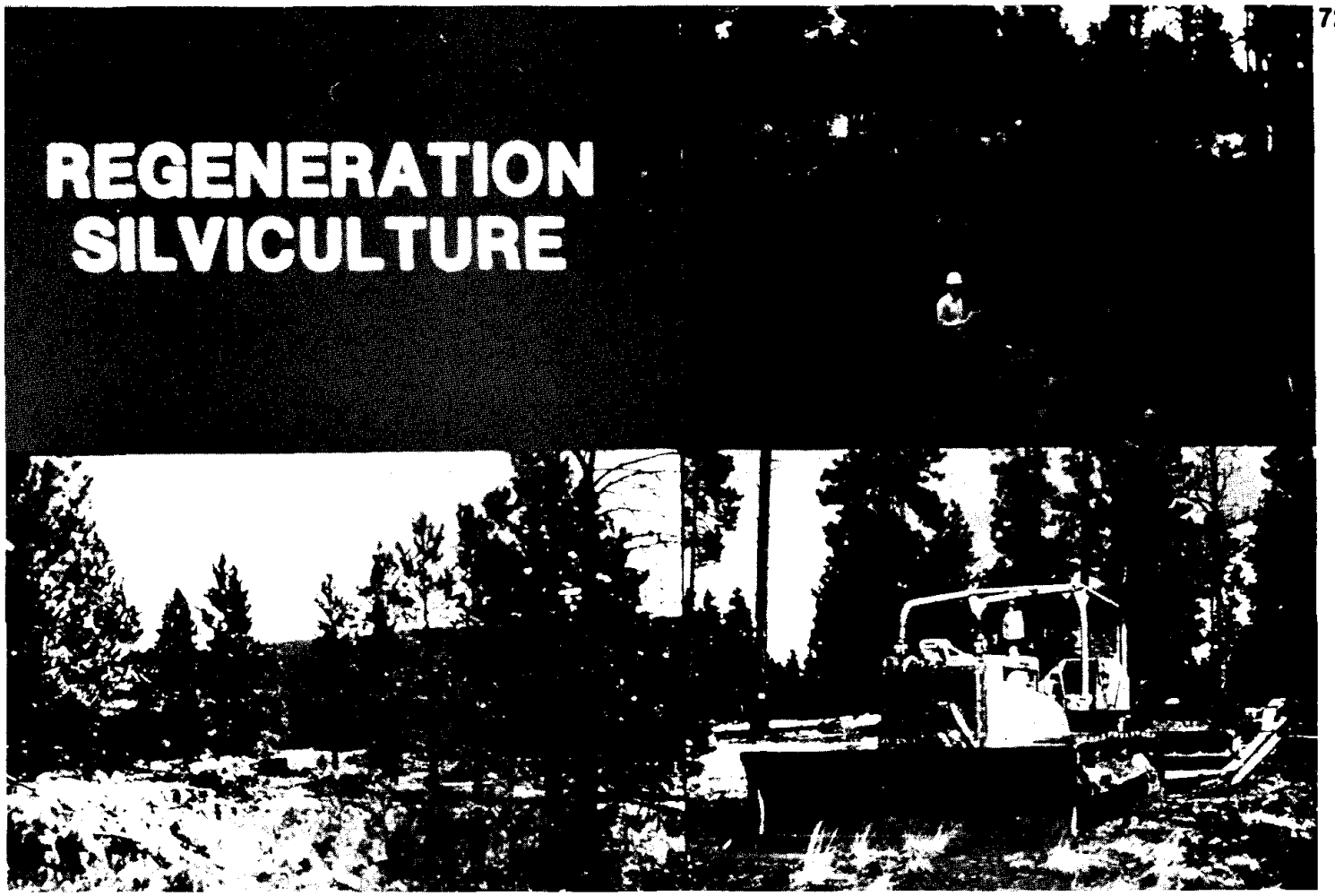
69. A heavily infected lower third would have a rating of "two."

70. Finally, add the ratings together to obtain an overall tree rating. An entire stand as well as individual trees can be rated by determining the percentage of trees infected in the stand. If you're interested in more details about this system, contact the Rocky Mountain Forest and Range Experiment Station in Fort Collins, CO.

71

71. And finally, western red rot and other fungi cause large volume losses in old-growth stands. Sanitation salvage cutting is about the only silvicultural control. It appears that young, managed stands are more resistant to these decay fungi; but they may be more susceptible to root rots.

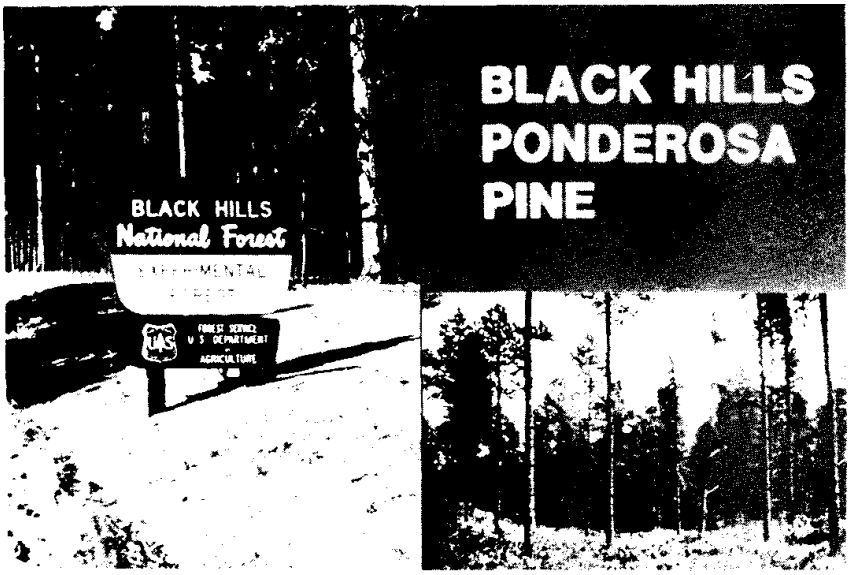
REGENERATION SILVICULTURE



72. Regeneration — either natural or artificial — is an important consideration in your management plan. The objective is to harvest timber and obtain adequate reproduction. Your choice of cutting methods depends on your management objectives and environmental conditions.

BLACK HILLS PONDEROSA PINE

73



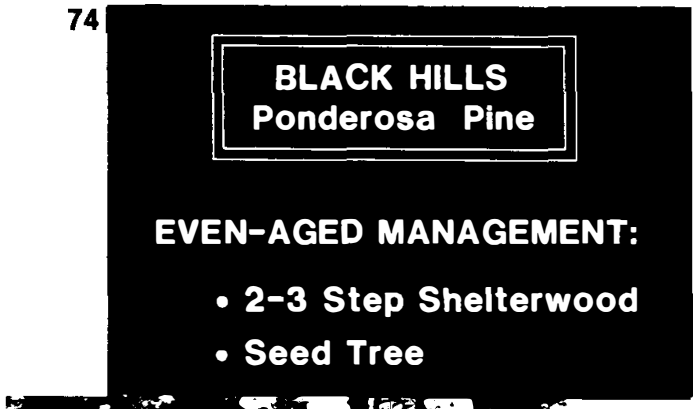
73. First, let's discuss cutting methods applicable to ponderosa pine stands in the Black Hills.

EVEN-AGED SYSTEMS
Shelterwood Cuts

74. In these stands, when your goal is even-aged management, the **shelterwood system** is the best harvesting method for most stand conditions. With this system you can take advantage of the species' natural habit of forming even-aged stands (Boldt and VanDusen 1974).

75. A shelterwood cut has the advantages of continuous vegetation protection, fair control over competitive ground cover, good control over slash, and assures an adequate, well distributed seed source.

74



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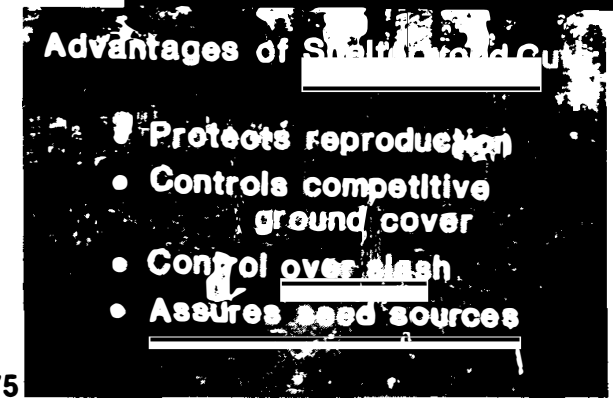


76. A uniform two-cut shelterwood is the most effective cutting method. However, a three-cut shelterwood can be used in very heavily stocked, mature stands . . .

77. . . . where slash buildup, risk of windfall, and logging damage to reproduction are problems.

Seed Tree Cuts

78. You can also successfully use the **seed-tree method.** For example, a few widely spaced seed trees compete less with new stand development. Fewer seed trees also reduce the chance of excessive reproduction and damage to new growth during final harvest.

79. On the other hand, a heavy first cut with a seed-tree method leaves more slash to treat, and the limited overstory encourages growth of competing vegetation. Also, your seed source may be lost due to mortality of high risk seed trees.

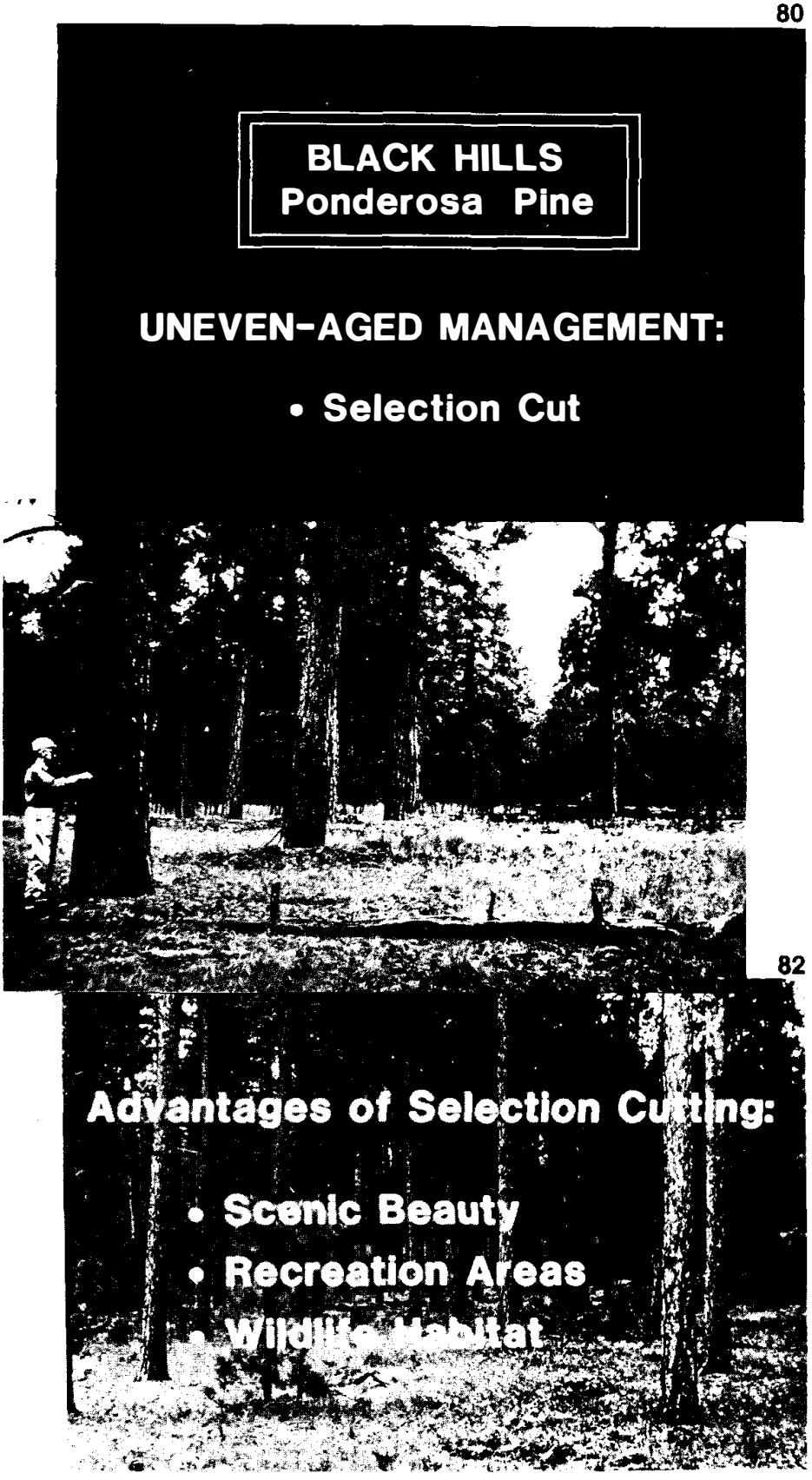
UNEVEN-AGED SYSTEMS
Selection Cuts

80. Uneven-aged management of ponderosa pine in the Black Hills is somewhat limited. The selection system, as a regeneration method, is out of place in the naturally even-aged forests — at least in regulated stands managed for timber production. But you can use individual tree selection for other purposes.

81. For example, with **individual tree selection,** you can maintain the health and appearance of mature stands and get the most from a few high-risk trees, when stands can't be harvested on schedule.

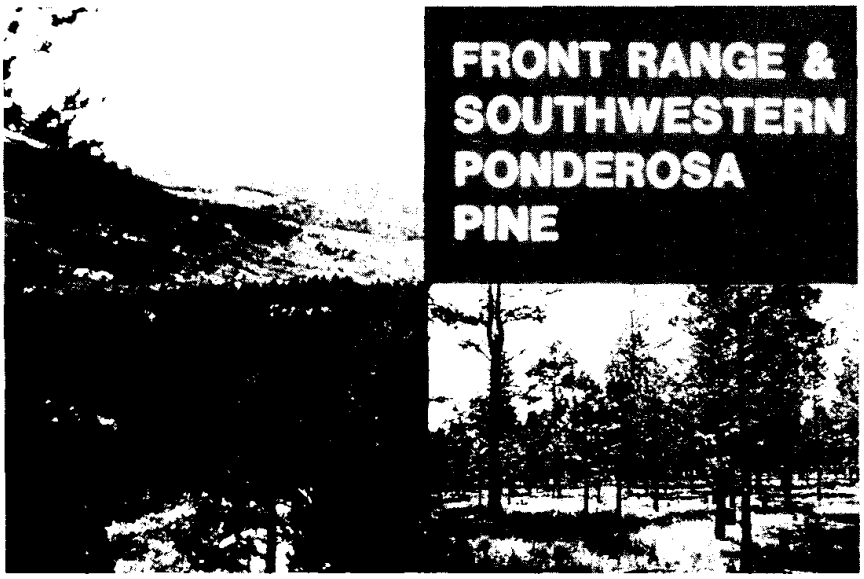
82. Selection cutting is a good silvicultural technique in stands where it's necessary to maintain scenic beauty, preserve a forested appearance in recreation areas, and improve wildlife habitat.

80



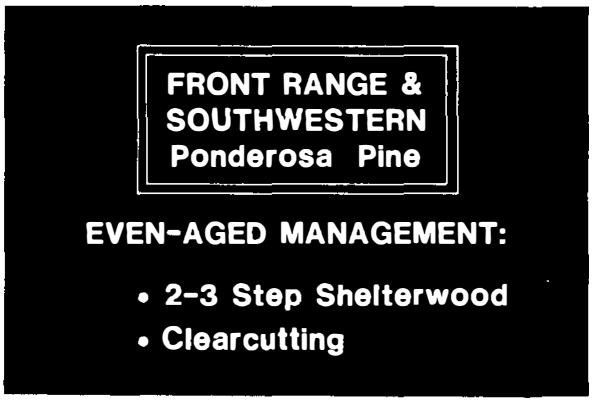
FRONT RANGE & SOUTHWESTERN PONDEROSA PINE

83



83. For Front Range and southwestern ponderosa pine, the two highly recommended cutting methods are **shelterwood** and **group selection.** However, you may also use **individual tree selection** and **clearcutting** under certain conditions. Many stands in the Front Range and Southwest can be managed as even-aged, uneven-aged, or converted from one management system to another (Myers 1974, Schubert 1974).

EVEN-AGED SYSTEMS
Shelterwood Cut



84

84. If your objective is an even-aged stand, use a two-step **shelterwood** for managed stands. But a three-step shelterwood is best for unmanaged stands or for those susceptible to windthrow.

85

85. The final harvest in either a two-step or three-step shelterwood is made soon after seedlings are established to encourage growth of new reproduction. However, your primary concern should be protecting the young trees from logging damage. Remember that logging damage to the understory seedlings and saplings will increase with stocking and tree height.

86. A shelterwood cut can also be used to convert existing uneven-aged stands to an even-aged structure. If you find that there isn't a manageable stand of advance reproduction, or that the overstory has a heavy volume, then you should use a two-step shelterwood.

87. On the other hand, if the overstory is light, with a fully stocked understory of advance growth, an **overwood removal** will release the new stand.

Clearcutting

88. Clearcutting is one even-aged method usually not recommended for ponderosa pine stands. However, you can **use clearcutting** to **reduce dwarf mistletoe** in heavily infected southwestern stands. Such cuts will have to be regenerated artificially by planting, as shown here.

UNEVEN-AGED SYSTEMS

89. At times it's best in Front Range and southwestern ponderosa pine to maintain stands in an uneven-aged structure.

89

Individual Tree Selection

90

90. Here trees may be **cut as individuals** scattered over the area . . .

Group Selection

91. . . . or in groups. **Group selection** should be used only if stand conditions and your management goals are compatible.

91

92. For example, many southwestern ponderosa pine forests are overstocked in smaller or larger diameter trees, while understocked in intermediates. By heavy group-selection cutting in overstocked size classes, you can, with some difficulty, convert these stands to uneven-aged management.

92

CUTTING RESTRICTIONS

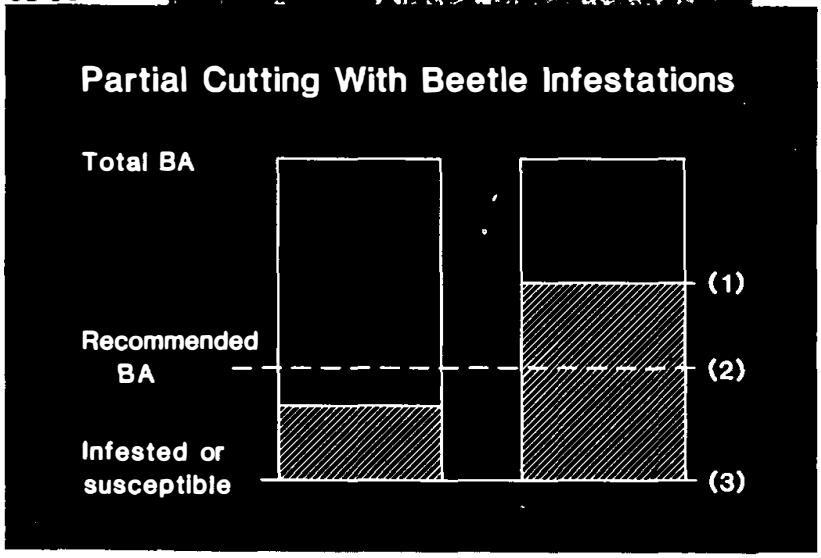
93

93. Once again it's important to emphasize that you must treat each stand on an individual basis. You may need to modify the cutting methods and silvicultural systems just discussed to fit your particular stand conditions.

MOUNTAIN PINE BEETLE INFESTATIONS

94

95-96



94. For instance, mountain pine beetle infestations may create situations where you need to adjust marking guidelines.

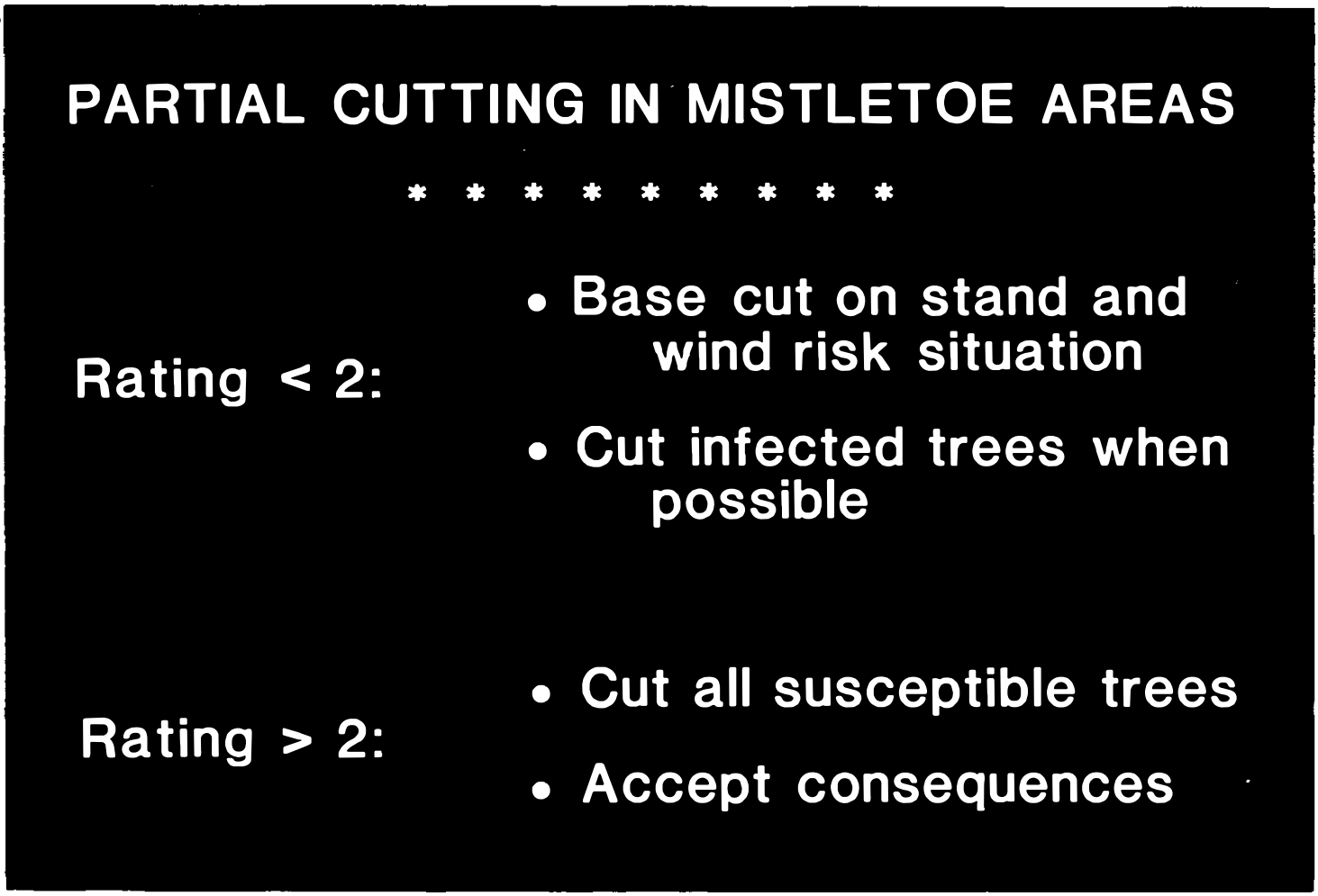
95. In some cases, (as seen on the left), you'll be able to remove all attacked and susceptible trees from a stand without exceeding the recommended basal area to be cut. However, this usually will include most of the larger trees in the stand, which may not leave a suitable seed source for natural regeneration.

96. If the basal area of infected or susceptible trees **exceeds the recommended percentage basal area** to be removed, as shown here on the right, you have three options. First, you may remove all attacked and susceptible trees, even if this results in clearcutting; second, you may remove the recommended basal area, cutting only some of the attacked and susceptible trees, and leave the remainder; or third, you may leave the entire stand uncut and accept the natural consequences.

97

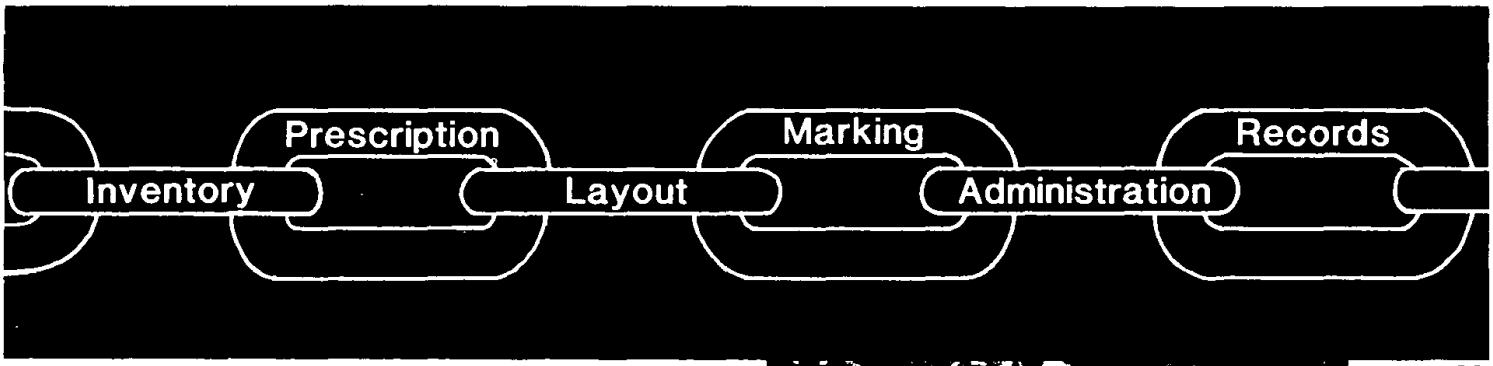
97. Other resource constraints may make clearcutting unacceptable in stands where beetle populations are building up. If stands are either partially cut or left uncut, there's a good chance that an outbreak will destroy most of the marketable trees and spread to nearby stands.

98



98. In a second case, you'll also need to adjust marking guidelines for mistletoe-infected stands. You should partially cut only those stands with a mistletoe rating of two or less. Remove as many infected trees as possible. If you have to make a lighter partial cut for any reason, then make the first cut heavy enough to be a regeneration cut . . . that is establish a new stand. Then, you need to remove all infected trees left standing, before the reproduction is 10 years old or before it reaches 3 feet in height.

CONCLUSION



99. Choosing the right cutting method is only one step in the whole process of silviculture. As you have seen, several operations are crucial to successful treatments. A breakdown, or failure of any part, will result in the failure of the entire process.

99

100. An accurate prescription is not possible without accurate inventory information. The best prescription will do the stand no good if improperly applied.

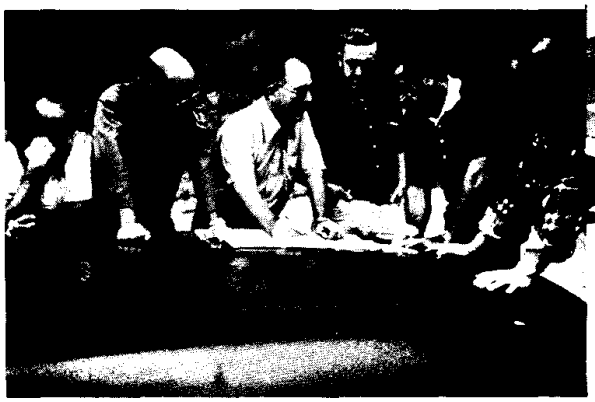
100

101. Sale layout and marking personnel need to fully understand the intentions of your prescription to carry out prescription requirements. Timber sale administrators have to ensure that logging activities can and do meet the requirements of the prescription.

102. Finally, accurate, long term records must be kept to ensure that future activities within the stand are consistent with your original prescription and that activities are properly scheduled and correctly applied.

101

103. Proper management is possible only if every member of your management team works together.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104

104. This program is one of a series giving the state of the art of silviculture of timber species in the central and southern Rocky Mountains. To obtain other slide programs in this series, or publications dealing with these subjects, contact the Forest Service headquarters of the Rocky Mountain Forest and Range Experiment Station in Fort Collins, Colorado.

105

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